

## PATENT

**Amendments to the Claims**

Following is a complete set of claims as amended with this Response. This complete set of claims includes amended claims 1 and 11.

1. (Currently Amended) ~~In an implantable defibrillator, a shocking circuit comprising:~~ A system to generate a defibrillation waveform, comprising:  
~~a set of capacitors; and~~  
an implantable defibrillator comprising a set of capacitors and switching circuitry connected to the capacitors and operative to selectively discharge the capacitors so as to generate a first phase of a biphasic defibrillation pulse waveform wherein the first phase of the waveform has at least three distinct voltage peaks.

2. (Previously Presented) The implantable defibrillator of Claim 1, wherein the set of capacitors comprises first, second and third capacitors.

3. (Previously Presented) The implantable defibrillator of Claim 2, wherein the switching circuitry is operative to:

generate a first step of the pulse waveform by discharging the capacitors while the first, second and third capacitors are connected in parallel;  
generate a second step of the pulse waveform by discharging the capacitors while the first and second capacitors are connected in parallel and the third capacitor is connected in series; and  
generate a third step of the pulse waveform by discharging the capacitors while the first, second and third capacitors are connected in series.

4. (Previously Presented) The implantable defibrillator of Claim 3, wherein the switching circuitry is operative to selectively discharge the capacitors during the three steps of the pulse waveform for respective first, second and third time periods selected to maximize a final myocardial voltage within myocardial tissue receiving the pulse waveform.

## PATENT

5. (Previously Presented) The implantable defibrillator of Claim 4, wherein the first, second and third time periods are represented, respectively, by:

$$d_1^{opt} = -\frac{\tau_m}{\alpha_1} \cdot \ln \left\{ \left( \frac{\tau_m}{\tau_{s1}} \right) \left( \frac{2 - \frac{\alpha_2}{\alpha_1}}{1 - \frac{\alpha_2}{\alpha_1}} \right) \right\};$$

$$d_2^{opt} = +\frac{\tau_m}{\alpha_2} \cdot \ln \left\{ \left( \frac{1}{2} \right) \left( \frac{2 - \frac{\alpha_2}{\alpha_1}}{1 - \frac{\alpha_2}{\alpha_1}} \right) \left( \frac{1 - \frac{\alpha_3}{\alpha_2}}{K_C - \frac{\alpha_3}{\alpha_2}} \right) \right\}; \text{ and}$$

$$d_3^{opt} = -\frac{\tau_m}{\alpha_3} \cdot \ln \left\{ \left( K_C \right) \left( \frac{1 - \frac{\alpha_3}{\alpha_2}}{K_C - \frac{\alpha_3}{\alpha_2}} \right) \right\}; \text{ wherein}$$

$$K_C = 1 + (C_C)/(C_A + C_B + C_C);$$

$$\alpha_1 = 1 - (\tau_m/\tau_{s1}), \alpha_2 = 1 - (\tau_m/\tau_{s2}), \text{ and } \alpha_3 = 1 - (\tau_m/\tau_{s3});$$

$$\tau_{s1} = R_s \cdot C_{s1}; \tau_{s2} = R_s \cdot C_{s2}; \text{ and } \tau_{s3} = R_s \cdot C_{s3};$$

$$C_{s1} = C_A + C_B + C_C;$$

$$C_{s2} = [(C_A + C_B) \cdot (C_C)]/[C_A + C_B + C_C];$$

$$C_{s3} = 1/\left[\frac{1}{C_A} + \frac{1}{C_B} + \frac{1}{C_C}\right];$$

$C_A$ ,  $C_B$ , &  $C_C$  are the respective capacitances of the first, second and third capacitors; and

$\tau_m$  is a predetermined myocardial tissue time constant.

6. (Previously Presented) The implantable defibrillator of Claim 2, wherein the capacitance of the capacitors are selected so as to minimize the amount of energy to be stored in the capacitors while maximizing a final myocardial voltage within myocardial tissue receiving the pulse waveform.

## PATENT

7. (Previously Presented) The implantable defibrillator of Claim 6, wherein capacitances of the first, second and third capacitors are represented, respectively, by:

$$C_A^{opt} = 0.6673 \cdot \left( \frac{\tau_m}{R_s} \right);$$

$$C_B^{opt} = 0.6673 \cdot \left( \frac{\tau_m}{R_s} \right); \text{ and}$$

$$C_C^{opt} = 1.5356 \cdot \left( \frac{\tau_m}{R_s} \right); \text{ wherein}$$

$R_s$  is a predetermined system resistance; and

$\tau_m$  is a predetermined myocardial tissue time constant.

8. (Previously Presented) The implantable defibrillator of Claim 6, wherein the capacitances of the first, second and third capacitors are represented, approximately, by:

$$C_A^{opt} = \left( \frac{2}{3} \right) \cdot \left( \frac{\tau_m}{R_s} \right);$$

$$C_B^{opt} = \left( \frac{2}{3} \right) \cdot \left( \frac{\tau_m}{R_s} \right); \text{ and}$$

$$C_C^{opt} = \left( \frac{3}{2} \right) \cdot \left( \frac{\tau_m}{R_s} \right).$$

9. (Previously Presented) The implantable defibrillator of Claim 6, wherein the switching circuitry is operative to selectively discharge the capacitors during the three steps of the pulse waveform for respective first, second and third time periods.

10. (Previously Presented) The implantable defibrillator of Claim 9, wherein the first, second and third time periods are represented, respectively, by:

$$d_1^{opt} = 0.878 \cdot \tau_m;$$

$$d_2^{opt} = 0.277 \cdot \tau_m; \text{ and}$$

$$d_3^{opt} = 0.200 \cdot \tau_m; \text{ wherein}$$

$\tau_m$  is a predetermined myocardial tissue time constant.

## PATENT

11. (Currently Amended) ~~In an implantable defibrillator having a set of capacitors, a method for generating a shocking pulse comprising the steps of~~ A method to generate a shocking pulse comprising:

providing an implantable defibrillator;

charging the a set of capacitors of the implantable defibrillator; and

selectively discharging the capacitors so as to generate a first phase of a biphasic defibrillation pulse waveform wherein the first phase of the waveform has at least three distinct voltage peaks.

12. (Original) The method of Claim 11 for use in a shocking circuit having first, second, and third capacitors and wherein the step of selectively discharging the capacitors includes the steps of:

generating a first step of the pulse waveform by discharging the capacitors while the first, second and third capacitors are connected in parallel;

generating a second step of the pulse waveform by discharging the capacitors while the first and second capacitors are connected in parallel and the third capacitor is connected in series; and

generating a third step of the pulse waveform by discharging the capacitors while the first, second and third capacitors are connected in series.

13. (Original) The method of Claim 12, wherein the steps of discharging the capacitors to generate the first, second and thirds steps of the pulse waveform are respectively performed for first, second and third time periods selected to maximize a final myocardial voltage within myocardial tissue receiving the pulse waveform.

## PATENT

14. (Original) The method of Claim 13, wherein the first, second and third time periods are represented, respectively, by:

$$d_1^{opt} = -\frac{\tau_m}{\alpha_1} \cdot \ln \left\{ \left( \frac{\tau_m}{\tau_{s1}} \right) \left( \frac{2 - \frac{\alpha_2}{\alpha_1}}{1 - \frac{\alpha_2}{\alpha_1}} \right) \right\};$$

$$d_2^{opt} = +\frac{\tau_m}{\alpha_2} \cdot \ln \left\{ \left( \frac{1}{2} \right) \left( \frac{2 - \frac{\alpha_2}{\alpha_1}}{1 - \frac{\alpha_2}{\alpha_1}} \right) \left( \frac{1 - \frac{\alpha_3}{\alpha_2}}{K_C - \frac{\alpha_3}{\alpha_2}} \right) \right\}; \text{ and}$$

$$d_3^{opt} = -\frac{\tau_m}{\alpha_3} \cdot \ln \left\{ \left( K_C \right) \left( \frac{1 - \frac{\alpha_3}{\alpha_2}}{K_C - \frac{\alpha_3}{\alpha_2}} \right) \right\}; \text{ wherein}$$

$$K_C = 1 + (C_C)/(C_A + C_B + C_C);$$

$$\alpha_1 = 1 - (\tau_m/\tau_{s1}), \alpha_2 = 1 - (\tau_m/\tau_{s2}), \text{ and } \alpha_3 = 1 - (\tau_m/\tau_{s3});$$

$$\tau_{s1} = R_s \cdot C_{s1}; \tau_{s2} = R_s \cdot C_{s2}; \text{ and } \tau_{s3} = R_s \cdot C_{s3};$$

$$C_{s1} = C_A + C_B + C_C;$$

$$C_{s2} = [(C_A + C_B) \cdot (C_C)]/[C_A + C_B + C_C];$$

$$C_{s3} = 1/\left[\frac{1}{C_A} + \frac{1}{C_B} + \frac{1}{C_C}\right];$$

$C_A$ ,  $C_B$ , &  $C_C$  are the respective capacitances of the first, second and third capacitors; and

$\tau_m$  is a predetermined myocardial tissue time constant.

15. (Original) The method of Claim 12 further including the initial step of selecting optimal capacitances for the capacitors so as to minimize the amount of energy to be stored in the capacitors while maximizing a final myocardial voltage within myocardial tissue receiving the pulse waveform.

## PATENT

16. (Previously Presented) The method of Claim 15, wherein the optimal capacitances of the first, second and third capacitors are represented, respectively, by:

$$C_A^{opt} = 0.6673 \cdot \left( \frac{\tau_m}{R_s} \right);$$

$$C_B^{opt} = 0.6673 \cdot \left( \frac{\tau_m}{R_s} \right); \text{ and}$$

$$C_C^{opt} = 1.5356 \cdot \left( \frac{\tau_m}{R_s} \right); \text{ wherein}$$

$R_s$  is a predetermined system resistance; and

$\tau_m$  is a predetermined myocardial tissue time constant.

17. (Cancelled)

18. (Original) The method of Claim 15 further including the step of selectively discharging the capacitors during the three steps of the pulse waveform for respective first, second and third time periods.

19. (Original) The method of Claim 18, wherein the first, second and third time periods are represented, respectively, by:

$$d_1^{opt} = 0.878 \cdot \tau_m;$$

$$d_2^{opt} = 0.277 \cdot \tau_m; \text{ and}$$

$$d_3^{opt} = 0.200 \cdot \tau_m; \text{ wherein}$$

$\tau_m$  is a predetermined myocardial tissue time constant.

**PATENT**

20. (Original) In a defibrillator having first, second and third capacitors, a shocking circuit comprising:

- means for charging the capacitors;
- means for generating a first step of a first phase of a defibrillation pulse waveform by discharging the capacitors while the first, second and third capacitors are connected in parallel;
- means for generating a second step of the first phase of the defibrillation pulse waveform by discharging the capacitors while the first and second capacitors are connected in parallel and the third capacitor is connected in series; and
- means for generating a third step of the first phase of the defibrillation pulse waveform by discharging the capacitors while the first, second and third capacitors are connected in series.

21. (Original) The system of Claim 20, wherein the means for discharging the capacitors to generate the first, second and third steps of the pulse waveform respectively operate for first, second and third time periods selected to maximize a final myocardial voltage within myocardial tissue receiving the pulse waveform.